> **Note:** It is suggested that the foldout at the back of the manual be extended when using this manual. The FOLDOUT, a front view of the AM-48, defines the numbers of the switches which are used to identify the switches throughout this manual.

Glossary. Refer to the Glossary to become familiar with the terminology used in this manual.

Power. Be sure to read Section 4 and observe the WARNING in ¶4.3 before powering up the AM-48.

Self Test. Perform the Self Test in Section 5 to:

1. confirm that all AM-48 circuits and basic functions are working properly, and
2. obtain "hands-on" experience with the AM-48 to learn how the controls operate.

Transmission Measurements. Note that Section 7, Operating Instructions, gives procedures to perform transmission measurements. For explanation and application of the measurements, see Section 8.

1.2 General Description

Definition and Purpose. In one (1) hand-held unit, the AM-48 provides the field engineer with two (2) instruments:

1. a transmission test set, and
2. a telephone "butt-set".

The transmission test set tests the integrity and quality of 2-wire or 4-wire voice and data transmission lines by sending selected analog signals and measuring standard parameters of the received signals.

The telephone "butt set" enables the field engineer to dial up and speak back-and-forth with a field engineer at the far end of the system. The compact and light-weight AM-48 eliminates the need to carry multiple, bulky test sets.

Functional Overview

AM-48 can send:

- any frequency from 200 Hz to 20 kHz @ -50 to +10 dBm
- continuous 3-tone slope (404, 1004, 2804 Hz)
- continuous, user-defined, sweep tones
- fixed 1004 Hz
- P/AR waveform
- momentary 2713 Hz for WECO 829 loopback

AM-48 can measure:

- level, -65 to +10.9 dBm (absolute or relative)
- frequency, 0 to 19,999 Hz
- idle channel noise
- noise with tone
- three-level impulse noise
- phase jitter
- gain jitter
- transients (dropouts, phase and gain hits, impulse noise)
- signal-to-noise (S/N) ratio
- peak-to-average ratio (P/AR)

Noise filters provided (each with optional 1010 Hz notch)::

- C-Message (Psophometric for AM-48E)
- 3 kHz
- 15 kHz
- Program (Sound-weighted for AM-48E)

Other features:

- High impedance bridge, 600 or 900 Ohm termination
- Display prompts help in set-up and testing sequences
- On-board memory can store & recall up to 10 user-defined test set-ups
- Dials: pulse, DTMF, and MF
- Talk/Listen capability
- Printer interface for hard copy of set-up and test results
- Battery life: Alkaline, 6 to 7 hours; NiCad, 3 to 4 hours
- NiCad batteries can be recharged without removing them from the unit

Testing Configurations: (For details, see ¶6.6)

There are three (3) basic AM-48 configurations used to test 2-wire/4-wire telephone/data communication lines:

1. End-to-end -- requiring two (2) AM-48 units
2. Loopback
3. Testing with responders

1.3 AM-48 Technical Specifications

AM-48 technical specifications are presented in four (4) parts:

1. General (Table 1-1)
2. Generator (Send) (Table 1-2)
3. Receiver (Measure) (Table 1-3)
4. Power/Physical (Table 1-4)

Table 1-1. AM-48 General Technical Specifications

Characteristic	Specification
Measurements	
Level	-65 to +10.9 dBm
Frequency	0 to 19,999 Hz
Noise	10 to 99 dBrn
Notched Noise	10 to 99 dBrn
Signal to Noise	0 to 60 dB
P/AR	0 to 120
Amplitude Jitter	0.0 to 25.0%
Phase Jitter	0.0 to 25.0 degrees
3-Level Impulse Noise	Counts from 0 to 9999
Transient Measurements	
Dropouts	0 to 9999
Gain Hits	0 to 9999
Phase Hits	0 to 9999
3-Level Impulse Noise	Counts from 0 to 9999
Dial	Built-in 16 button keypad for dial pulse, DTMF (Touch Tone), or MF dialing.
Talk	Built-in microphone and speaker with push-to-talk operation on both 2-wire and 4-wire lines. Earphone jack for optional earphone.
Holding	A single line holding circuit is provided for 2-wire operation, or the send pair of 4-wire circuits. It electronically simulates a holding coil with a DC resistance of approximately 200 ohms. The AC impedance is high enough to give no more than 0.2 dB loss at 600 ohm impedance.
Impedances	600 and 900 ohm.
	Balance > 60 dB below 4 kHz, decreasing 6 dB.octave above 5 kHz.
	Return loss > 30 dB 200-5000 Hz, > 15 dB 5-20 kHz.
	DC blocking - 150 Volts.
	Bridging impedance > 25 kohms.

Characteristic	Specification
Printer	Current loop interface to optional printer for hard copy of unit setup and measurement results
Store/Recall	10 complete unit setups may be stored by user in internal nonvolatile memory, and recalled for ease of repeating frequently-used tests. In addition, the results of the last impulse or transient study (along with the associated setups) are stored to nonvolatile memory at the completion of the study. They are recalled automatically whenever the unit is turned on. Also stored in nonvolatile memory are four (4) user-set parameters (each set from the QUIET mode): 1. Touch Tone/MF Dial Level 2. Power Down Time with momentary power switch 3. Blanking interval for impulse and transient tests 4. 10 user-programmable momentary frequencies

Table 1-2. AM-48 Generator (Send) Technical Specifications

Characteristic	Specification
Variable	Frequency: 200 Hz to 19,999 Hz in 1 Hz steps. Frequency may be entered directly via the keypad or stepped up or down in 10 Hz steps with auto-repeat steps of 100 Hz (4 steps/second) for fast frequency slewing. Frequencies are crystal-controlled and accurate to ±.72 Hz ±.01%. Level: -50.0 dBm to +10.0 dBm in .1 dB steps. Level may be entered directly via the keypad or stepped up or down in .1 dB steps with auto-repeat steps of 1.0 dB (4 steps/second) for fast level slewing. Level accuracy is as follows: 200 Hz 15 kHz 20 kHz +10 dBm ±0.2 ±0.5 -40 dBm -50 dBm ±0.5 ±1.0
1004 Hz	A fixed 1004 Hz holding tone is provided. The frequency is accurate to ±.025%. Level is the same as variable.

Characteristic	Specification
3-Tone	A three-tone slope frequency mode is provided, which cycles continuously between 404 Hz, 1004 Hz, and 2804 Hz, giving 5 seconds of each tone. Frequency accuracy is the same as variable. Level is the same as variable.
Sweep	A programmable frequency sweep generator is provided. It generates tones continuously from a user-specified START frequency (200 Hz to 19,999 Hz) to a user-specified STOP frequency (200 Hz to 19,999 Hz), at a user-specified frequency STEP interval (1 Hz to 19,999 Hz), and at a user-specified step RATE (0.1 second to 19,999 seconds/frequency). Frequency accuracy is the same as variable. Level is the same as variable.
PAR	A PAR waveform generator is provided, which generates the 16 simultaneous frequency PAR waveform per Bell 41009 specifications. The level may be set from -40.0 dBm to 0.0 dBm, with 0.1 dBm resolution. Level accuracy is ±0.5 dBm.
Quiet	In quiet mode, the line is terminated with a passive resistance equal to the line impedance. Also, when in Quiet, one of 10 user-programmable tones may be momentarily applied to the line by depressing the (0) thru (9) keys. Programmable from this mode are (1) Touch Tone dial level (-50.0 to 7 dBm), (2) Power down Time Off (1 to 255 minutes), (3) Impulse and Transient test Blanking Interval (1 to 255 ms), and (4) 10 user-programmable tones for later instant recall.
Aux Tone	A momentary pushbutton is provided for the generation of an auxiliary tone (2713 Hz), used to activate remote 829-type loopback devices.
SF Skip	A Signaling Frequency (SF) Skip mode prevents the generation of tones between 2450 Hz and 2750 Hz in variable or sweep modes.
Distortion	Total distortion is < -50 dB @ 1004 fixed tone and < -40 dB @ any other frequency.

Table 1-3. AM-48 Receiver (Measure) Technical Specifications

Characteristic	Specification
Level/Freq	Level is measured with an average responding detector. Range is -65.0 to +10.9 dBm with 0.1 dBm resolution. Accuracy is as follows: 200 Hz 15 kHz 20 kHz +10 dBm ±0.2 ±0.5 -40 dBm -65 dBm ±0.4 ±0.8 **Note:** Accuracy is ±0.1 dBm at 1004 Hz from -20 dBm to 0.0 dBm. Frequency is measured from 200 Hz to 19,999 Hz with an accuracy of ±.01% ±1 Hz, and a resolution of 1 Hz. Input level -40 to +10 dBm.
PAR	Peak-to-Average Ratio (PAR) is measured from 0 to 120 PAR units to a resolution of 1 PAR unit. Accuracy is ±2 from 30 to 110, ±4 from 0 to 120 over a signal range of -40 to 0 dBm. PAR signal level is measured from -40 to 0 dBm, with a resolution of 1 dBm, using an RMS detector.
Noise	Noise is measured with an RMS responding detector from 10 to 99 dBrn to 1 dBrn resolution. Accuracy is ±1 dBrn from 20 to 99 dBrn, and ±2 dBrn from 10 to 20 dBrn. Weighting Filters are 3 kHz flat, 15 kHz flat, CMSG, and Program filter.
Notched Noise	Notched Noise is the same as noise with the addition of a 1010 Hz notch filter, minimum 50 dB deep from 995 to 1025 Hz.
S/N ratio	Signal-to-Noise (S/N) ratio display the ratio of signal (holding tone) to notched noise. The signal must be -40 to +10 dBm. The notched noise may be 10 to 70 dBrn. The S/N ratio may be from 10 to 50 dB. Resolution is 1 dB. Accuracy is ±1 dB for notched noise 20 to 70 dBrn, and ±2 dB for notched noise from 10 to 20 dBrn.

Characteristic	Specification
Amplitude Jitter	Displays the incidental amplitude modulation of a holding tone. The holding tone must be -40 to +10 dBm, 990 to 1030 Hz. Amplitude jitter is displayed from 0.0 to 25.0% with a resolution of .1% and an accuracy of ±.2%, ±5% of reading. Weighting filter selection: 20-300 Hz or 4-300 Hz.
Phase Jitter	Displays the incidental phase modulation of a holding tone. The holding tone must be -40 to +10 dBm, 990 to 1030 Hz. Phase jitter is displayed in degrees from 0.0 to 25.0 degrees with a resolution of .1 degree and an accuracy of ±.2 degree, ±5% of reading. Weighting filter selection: 20-300 Hz or 4-300 Hz.
Impulse Noise	Three (3) noise thresholds are established: Low, Middle, and High levels, with an equal interval between them called the Delta. The maximum High threshold is 105 dBrn for 600 ohm impedance (or 104 dBrn for 900 ohm). The minimum Low threshold is 30 dBrn. Delta can be 2, 3, 4, or 6 dB. Threshold accuracy: ±1 dB. A user-selected blanking interval of 1 to 255 ms for each threshold, blocks further counting of impulses at that threshold. The study duration timer may be set from .1 minute to 1999.9 minutes in .1 minute steps, or continuous. Each threshold has a count capacity of 0-9999. Weighting filters same as noise.
Transients	Counts dropouts, gain hits, phase hits, and 3-level impulse noise with tone. Holding tone must be -40 to +10 dBm, 995 to 1025 Hz Dropout threshold is -12 dB from the initial level of the holding tone. A dropout will be counted if the holding tone drops below the threshold for at least 4 ms ±.5 ms. Counting of dropouts, gain hits, phase hits, and impulses is inhibited for a blanking interval which lasts until 1 second after the holding tone is restored to a level above the dropout threshold.

Characteristic	Specification
Transients (cont.)	Gain hit threshold can be 2, 3, 4, or 6 dB. A gain hit will be counted if the level of the holding tone changes up or down by more than the threshold for at least 4 ms ±.5 ms. A blanking interval, that is user-set from 1 to 255 ms, blocks further counting of gain hits. Phase hit threshold can be 5 to 45 degrees in 1 degree steps, with an accuracy of ±.5 degrees ±10% of the setting. A phase hit will be counted if the phase of the holding tone changes by more than the threshold fro at least 4 ms ±.5 ms. A blanking interval, that is user-set from 1 to 255 ms, blocks further counting of phase hits. The three-level impulse noise low threshold can be set from 30 to 110 dBrn with threshold differences of 2, 3, 4, or 6 dB. Threshold accuracy: ±1 dB. An independent blanking interval for each threshold, user-set from 1 to 255 ms, blocks further counting of impulses at that threshold. The study duration timer may be set from .1 minute to 1999.9 minutes in .1 minute steps, or set to 0 for a continuous study. Each transient has a count capacity of 0-9999. Filters same as noise.
Damping	A damp mode reduces the display update rate from approximately 4 times/second to approximately 2 times/second for reading widely fluctuating measurements. The same switch, when in <DAMP> position, also changes the monitoring point of the receive (RCV) monitor speaker to the output of the auto-range amplifier (significantly increasing the speaker level).
Term/Bridge	When in terminate, the receiver terminates the line in the selected impedance. When in bridge, the line is bridged by a high impedance, causing no more than .2 dB loss on a 600 ohm line.

Table 1-4. AM-48 Power/Physical Technical Specifications

Characteristic	Specification
Power	Four 1.5 VDC "AA" alkaline batteries provide about six hours operation. NiCad batteries provide about half the life of alkaline. External AC adapter powers unit from 120 VAC and charges optional NiCad batteries in the unit. Auto shutoff after last switch actuation is user-programmable for 0 (no shutoff), or from 1 to 255 minutes. May be overridden by placing power switch in the <ON> position. Does not turn itself off while timed study is in progress.
Physical	Size: 4.2" (106mm)W x 7.6" (193mm)H x 1.7" (43mm) D. Weight: 23 oz. with alkaline batteries (slightly less with NiCad). Connections to phone line via dual bantam jacks and RJ11C modular jack.

1.4 AM-48E Technical Specifications

AM-48E is an international version transmission test set which meets CCITT standards. All specifications for the AM-48 in Tables 1-1 thru 1-4 are identical for the AM-48E, except as described below:

1. Instead of the C-Message (CMSG) noise-weighting filter, the AM-48E has the Psophometric (PSHO) noise-weighting filter. See Figures 3-6 and 3-7.
2. Instead of the Program (PROG) noise-weighting filter, the AM-48E has the Sound-weighted (SWTD) filter. See Figures 3-6 and 3-7.
3. Instead of the 3TONE slope frequency send mode of 404 Hz, 1004 Hz, and 2804 Hz @ 5 seconds, the AM-48E has a 4-tone SLOPE frequency send mode of 404 Hz, 1004 Hz, 2004 Hz, and 3004 Hz @ 5 seconds. See Figures 3-6 and 3-7.

4. Instead of Signal Frequency (SF) Skip 2450 Hz to 2750 Hz, the AM-48E has SF SKIP from 2130 Hz to 2430 Hz.

5. On all noise displays, instead of units of dBrn, the AM-48E displays the noise in units of dBm. See ¶8.2 and Figure 8-1 for definitions and corresponding values of dBrn and dBm units.